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Mail Ballot Signature Rejections: Household Members Signing Each Other's Ballots

Craig Wilding
University of Central Florida

MAIL BALLOT SIGNATURE REJECTIONS: HOUSEHOLD MEMBERS SIGNING EACH OTHER'S BALLOTS

by

CRAIG WILDING
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ABSTRACT

Election administrators anecdotally mention that many ballots get signed by someone else in the household, such as the husband signing the wife's ballot. If household members are signing each other's ballots mistakenly, then there should be a rise in mismatched signatures as the number of people in the household increases. By matching household addresses of registered voters and the addresses that ballots were mailed to from the 2020 Florida general election, the study found that the probability of a signature mismatch did increase as the number of household members increased. While the data showed that black and Hispanic households have more people in a household, the household size did not account for the higher rates of signature mismatches among blacks and Hispanics.

This research proposes placing the voter's name under the signature line to reduce the number of mismatched signatures. Other envelope design features, such as arrows, power of attorney notices, and layout, were measured to determine the effectiveness of envelope designs. Simpler design features were more effective. If the voter's name can be added under the signature line without disruption, it could decrease the number of ballots signed by the wrong household member.

Overall, household members signing the wrong ballot contribute approximately one additional mismatched signature per 100,000 ballots. With over 15 million voters in Florida, where close elections and recounts are the norm, preventing this problem from occurring can make a difference in electoral outcomes.

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LIST OF ACRONYMS

CI	Confidence Interval
DMV	Department of Motor Vehicles
EAC	US Election Assistance Commission
EAVS	Election Administration and Voting Survey
HAVA	Help America Vote Act
FL DOE	Florida Division of Elections
FSE	Florida Supervisors of Elections
FVAP	Federal Voting Assistance Program
FVRS	Florida Voter Registration System
NCSL	National Conference of State Legislatures
NVRA	National Voter Registration Act
SOE	Supervisor of Elections
UOCAVA	Uniformed and Overseas Citizens Absentee Voting Act
VBM	Vote-by-Mail

INTRODUCTION

In 2018, a report by the ACLU found that mail ballots in Florida had a higher rejection rate for young and ethnic minority voters (Smith, 2018). While the report did not claim racial bias by election administrators as a cause, subsequent news reports (Lemongello, 2018) (Robinson, 2018) and public opinion frequently jumped to that conclusion, especially around the effects on minority voters. But what part of the signature verification process would lead to signatures from black or Hispanic voters getting rejected more frequently? Signatures are scanned and compared by the same machines used for bank and credit card transactions, so how is there a bias in the signature verification machines used by election administrators but not in those used for business? Would the signature verification machines even be able to distinguish if a signature were from a black or white voter?

In Florida, canvassing boards that review rejected signatures are open to public viewing. I attended one for the 2020 primary election and learned about a particular phenomenon. Household members would sign the wrong envelope, such as the husband signing the wife's envelope and vice-versa. The election officials said it was quite common and is usually resolved as long as both family members return the missigned envelopes. This gave me a new theory to investigate for signature rejections. Suspecting that black and Hispanic voters have larger numbers of people in their households, I hypothesized that their higher rejection rate could be due to having a larger household size.

The household size effect could have a simple solution: place the voter's name under the signature line. Legal documents commonly include the person's name and/or title as indicators

beneath the signature line to show who is supposed to sign where. This common design tactic could be used to help resolve some of the signature mismatches. Before testing a ballot envelope design, however, I first needed to determine whether the problem of household members signing the wrong ballot is a significant problem worth addressing, or is it merely anecdotal? I reasoned that if household members were signing each other's ballots mistakenly, then the frequency of mismatched signatures should increase as the number of people in the household increases.

I collected the Vote-by-Mail reports from the 2020 Florida general election. The Vote-by-Mail reports identify whether a ballot had a missing a signature or a mismatched signature and include the date when it was returned to the election administration office. This allowed for the classification of rejected ballots as either late, unsigned, or mismatched. I matched the mail ballot addresses and addresses from the voter file to get a count of voters in the household. Analysis showed there is a household size effect with more signature mismatches occurring as the household size increases. This empirically demonstrates that household members are mistakenly signing each other's ballots.

I also requested a copy of the 2020 mail ballot envelopes from all of Florida's 67 counties. I found that ballot envelope designs had similarities among the counties, but there was no common ballot envelope design used by all counties. Having the mail ballot envelopes allowed me to test the effect of variations in ballot envelope designs. For example, was it effective to have an arrow on the front of the envelope reminding the voter to sign the back? Effective changes in mail ballot envelope design could be a way to reduce signature errors and increase the number of intended votes that are counted.

LITERATURE REVIEW

There is a small subfield of political science research that looks at mail ballot rejection. I classify these studies into two camps. The first camp of research gives an overview of common election processes across multiple states and gives recommendations for which methods work better. See (Burden & Gaines, 2013), (Neisler, 2020), and (Montjoy, 2008). Because election laws vary by state, these give an overall description of the election process, highlight where the main differences are, and may give a high-level recommendation of best practices. The second camp of research focuses on rules and results within a single state. See (Smith, 2018), (Baringer, Herron, & Smith, 2020), (Alvarez, Hall, & Sinclair, 2008), (Cottrell, Herron, & Smith, 2021), and (Shino, Suttmann-Lea, & Smith, 2021). By focusing on election results from a single state, these studies gain more insight into who is affected by the election processes in place. While there is still some variance in election procedures by county (Alvarez, Hall, & Sinclair, 2008), focusing on one state gives enough results to measure for significance while controlling for county-fixed effects. This approach also allows the study to test specific theories on what causes ballot rejection, such as the number of letters in the name (Baringer, Herron, & Smith, 2020), or the voter's prior experience with mail ballots (Cottrell, Herron, & Smith, 2021). Because my study focuses on testing the theory that the number of people in the household affects the number of mismatched signatures, the literature review focuses on research in the second camp that offers more detailed studies based on election results.

Does Race Matter?

Returning to the ACLU report, while it reports that mail ballots for racial minorities were rejected two-and-a-half times as often as whites (Smith, 2018, p. 13), the report does not include

statistical analysis that would validate if these differences are statistically significant. The report merely compares the percentages between ethnic groups and election years and notes the difference in rates. It does not determine whether race was significant or was a causal factor.

Fortunately, two other reports analyzed the same Florida election data used by the ACLU report and applied statistical methods that addressed my concern. The first study by Baringer, Herron, & Smith (2020, p. 307) confirms that while blacks and Hispanics had a higher ballot rejection rate than whites, the difference was not statistically significant once other factors for party and gender were included which accounted for the difference. This study also included analysis of name complexity such as including a middle name, a hyphen, apostrophe, or other special characters which Hispanic names frequently include. None of the complex names caused a significant difference in signature rejection. Instead, the name discrepancies tended to decrease the chances of the signature being rejected (Baringer, Herron, & Smith, 2020). This is in line, though, with the forensic signature literature, which focuses on the overall handwriting style rather than making sure that all i's are dotted, and t's are crossed. While Hispanic names might be rejected by signature matching machinery, name complexity may have the opposite effect on human inspection as it gives the viewer more cues to look for. This gives reason to believe that Hispanic signatures should not have more rejections than white signatures. Rejection rates for Hispanics may have more to do with an unclear translation of the instructions or an inability to get help from election officials (White, Nathan, & Faller, 2015).

A second report by Cottrell, Herron, and Smith (2021) addressed the effects of voter experience, which could account for age effects found in the ACLU report (Smith, 2018). It found that voters who had not previously used mail ballots had higher mail ballot rejection rates

universally across late, unsigned, and signature mismatched ballots (Cottrell, Herron, & Smith, 2021, p. 13). Even controlling for experience, however, there was still an age effect where young voters, even those experienced with mail voting, were more likely to return the ballot late than were older voters without mail ballot experience (Cottrell, Herron, & Smith, 2021, p. 20). For signature mismatches, however, margins based on race, sex, or age were negligible (Cottrell, Herron, & Smith, 2021, p. 23).

Research from other states produced mixed results. A study using Georgia mail ballots found race was not significant for late ballots but was for rejected signatures (Shino, Suttmann-Lea, & Smith, 2021). Other studies on race and elections focus on minority turnout (Elul, Freeder, & Grumbach, 2017), (Pryor, Herrick, & Davis, 2019), (Hajnal, Lajevardi, & Nielson, 2017) or lack of information available to minorities (White, Nathan, & Faller, 2015). However, these only explain the disenfranchisement effects of who gets to vote. They do not explain the ballot rejection of those that do manage to vote. The mixed results of race on ballot rejections indicate there may be some bias due to race, but we do not yet fully understand why. This emphasizes the need to look deeper into the election process for any potential bias.

Late, Unsigned, and Mismatched Signatures

Cottrell, Herron, and Smith (2021) separate ballot rejections into three types: ballots arriving late, unsigned ballots, and ballots with a voter error. Most ballots were rejected because they were late. Voter error was the least common reason (Cottrell, Herron, & Smith, 2021, p. 10). Voter error is mostly attributable to mismatched signatures where the signature on the ballot is rejected because it does not match the voter's signature on file. There are other minor reasons, such as duplicates or the voter died (Burden & Gaines, 2013). For the purposes of my research,

ballots marked as voter errors that were not late or unsigned were counted as mismatched signatures. This is in keeping with current research methods in this field of study (Baringer, Herron, & Smith, 2020) (Cottrell, Herron, & Smith, 2021).

Reporting on these three issues separately is important not only for research but also for media reporting. When news or social media report large numbers of ballot rejections, the reaction is to believe there is ballot fraud whether it happened or not (Burden & Gaines, 2013). Therefore, it is important to be clear and consistent when reporting ballot rejections and include the type of ballot rejection – mail ballots being late, unsigned, or signature mismatches – that is causing it. For example, reporting a large number of mail ballot rejections without indicating that the mail ballots arrived late can imply a bias in signature verification by election officials rather than user error of the voter waiting too long to send it. Unfortunately, the type of rejection may not be reported in all states. Some states only report that a mail ballot was rejected and do not give more detailed reasons, which can lead to speculation of bias.

In the 2020 presidential election, concern arose over how to count late ballots, and court cases ensued (Shamsian, 2020) (Fessler, 2020) (Gringlas, 2020). The main contention was over how states declare a ballot to be on time. Some states allow ballots to arrive after election day as long as they are postmarked before the election, while other states require the ballot to arrive at the election office by election day. Late ballots are additionally problematic for military and overseas voters (Alvarez, Hall, & Roberts, 2007) (Coleman, 2012). Under the Uniformed and Overseas Citizens Absentee Voting Act (UOCAVA), ballots must be sent to military and overseas citizens 45 days before a federal election (FVAP.gov, 2021). However, the deadline to return military ballots still varies by state hinging on either arrival time or postmark dates as

noted above. States may allow a later deadline or accept postmarks on UOCAVA ballots that differ from the rules for civilian mail ballots. While this is a good practice that allows more time for military and overseas voters, the different deadline rules pose a constitutional question of equal protection for voters which is the prevalent requirement since Bush v. Gore (2000).

Signature Verification Devices

Because signature verification is used in a variety of commercial uses, there are whole fields of research around the topic. Forensic studies of signatures take a more traditional route, observing differences in slant, letter size, and spacing (Mohammed, Found, Caligiuri, & Rogers, 2015) (Marquis, Cadola, Mazzella, & Hicks, 2017). Computer and engineering fields apply these forensic methods to the digital world, focusing on matching algorithms used by signature verification devices. See (Diaz, et al., 2019), (Jain, Griess, & Connell, 2002), (Cpalka & Zalasinski, 2014). Mail ballot processing devices used by election administrators use this signature matching technology to validate signatures. Signatures rejected by the machines are then evaluated by election officials. Experience with forensic signature matching is what election officials ultimately rely upon for inspecting ballots rejected by the automated systems, though the level of experience of election workers and election officials varies widely (Janover & Westphal, 2020).

A survey of California election officials showed that only the largest used automatic signature verification systems. Most only used machines that would capture the image of the signature while sorting the ballots but not validate the signatures. The signature image scanned from the ballot would then be compared to the signature on the voter file by election staff (Janover & Westphal, 2020). The use of technology was related to the county size. Smaller

counties normally did everything by hand using election workers, but counties with populations in the millions frequently used more automated systems just to get through all of the ballots on time. Janover and Westphal (2020) noted, though, that all ballots with a signature mismatch were reviewed by at least two people in all counties.

Janover and Westphal (2020) also gathered comments from election administrators on abnormalities that made signature verification difficult. This included: signatures becoming shaky with age; cursive handwriting no longer being taught to younger generations; the DMV using a pen pad for the signature which produces a slightly different signature than the paper signature provided on the ballot; younger people using hearts and emojis in their original registration signatures but omitting them years later (Janover & Westphal, 2020, p. 331). Some of these may cause a difference by race or age in rejections by machines, but they would still be reviewed by a human who could mitigate these problems. The list, however, represents issues that could be further researched but go ignored as insubstantial problems.

Household Mismatches

Two articles noted election officials mentioning the problem of family members signing the wrong ballot, but it was not considered a substantial problem (Janover & Westphal, 2020) (Cottrell, Herron, & Smith, 2021). It could be that the problem was easy for election officials to reconcile so it did not appear to them as problematic, or the problem truly could be minor, as they suggest. Still, if the household size effect can explain part of the reason for racial bias in rejections, it is worth investigating. Also, if the cost of implementing a solution (i.e., placing the name under the signature line to prevent the problem) is low, then the solution may also be worth implementing, even for a minor problem.

Ballot Design

Most studies on ballot design focus on the ballot where the voter's choices are recorded rather than the envelope where the signature is. This is because poor ballot design can cause overvotes or undervotes, which can change election results. For example, the 2018 ballot for Broward County, Florida, was found to have a design that caused voters to skip over the first race for US Senate (Ross, 2020). It appeared below the ballot instructions causing an undervote for the race (McCadney & Norden, 2020).

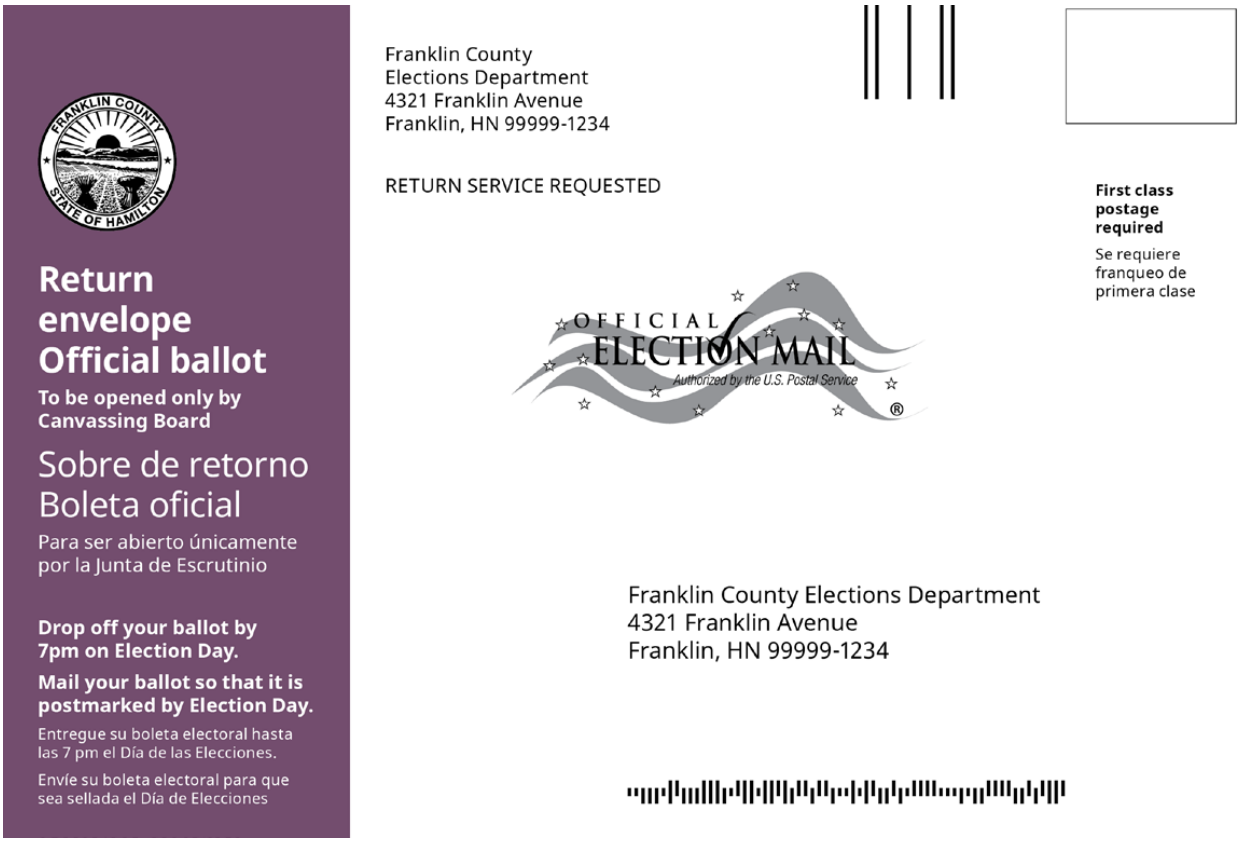


Figure 1 Center for Civic Design Return Ballot

Source: Center for Civic Design (2020)

There are design guidelines and templates for ballot envelopes widely available. The Federal Voting Assistance Program (FVAP), US Election Assistance Commission (EAC), National Conference of State Legislatures (NCSL), the Center for Civic Design, and the US Postal Service all offer templates, guidance, and requirements for designing ballot envelopes. While design templates are readily available, the ballot envelopes I received from the Florida counties show they are seldom used. The Center for Civic Design envelope uses a distinctive coloring on the left side of the return envelope to distinguish it while being processed through the US postal service (Figure 1). Out of the 64 Florida counties that supplied me with a sample of their ballot envelope, only three used the Center for Civic Design envelope (Center for Civic Design, 2020).

Though few Florida election offices have adopted the Center for Civic Design envelope, there were common design elements used from county to county. Roughly one-third of the counties used the red box from Figure 2 for the signature area. The rest use a plain box as in Figure 3 or some variation in between. The commonality indicates that local election officials will frequently copy off of each other. This in turn produces a standard template in place of one designated by the state. In 2017, the Florida Supervisors of Elections (FSE) conference included a presentation on mail ballot designs that various county Supervisors of Elections had used (Conte, 2017). This indicates some willingness of local election officials to try improvements but also an overall reliance on seeing what others do and getting feedback on the results before others implement the changes.

Figure 2 Red Box Return Envelope Design

Source: Seminole County SOE (2020)

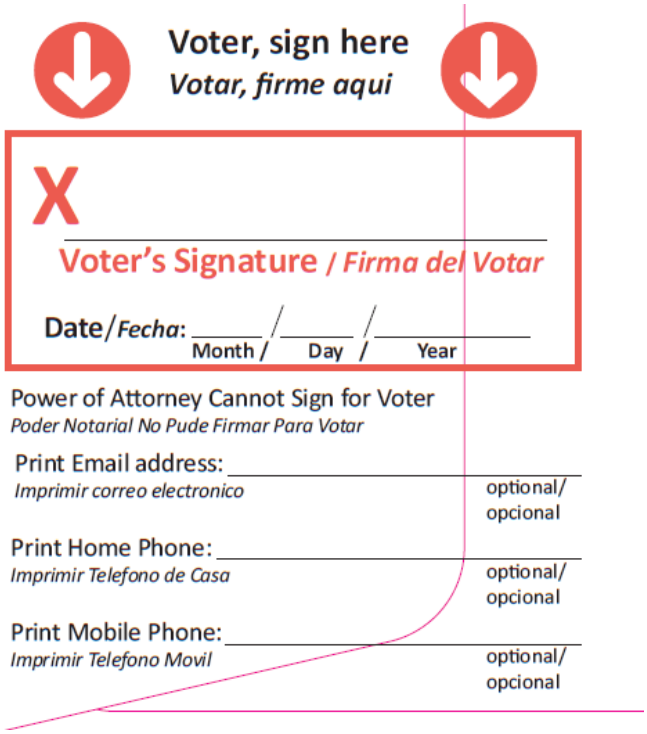


Figure 3 Plain Signature Box

Source: Escambia County SOE (2020)

THEORY AND HYPOTHESIS

How often are household members signing the wrong ballot? Election officials have given researchers anecdotal evidence that household members will mistakenly sign the wrong ballot (Janover & Westphal, 2020) (Cottrell, Herron, & Smith, 2021). But both election officials and researchers have treated it as a minor anomaly and not investigated further. If this is an actual problem, though, then empirical evidence should be able to indicate the frequency at which it occurs. This will allow researchers to quantify the scope of the problem and allow election officials to weigh its likelihood and costs against other issues.

Household effect on mismatched signatures

***H1**: In a comparison of people who voted by mail, voters with a larger household count are more likely to have their ballot rejected as a signature mismatch than voters with no one else in the household.*

If household members are signing each other's ballots mistakenly, then there should be a rise in mismatched signatures as the number of people in the household increases. Household size would initially be the number of registered voters in the household, but it is further complicated by mail voting since the ballot may be mailed to a different address. For household members to sign the wrong ballot, the ballots have to end up at the same house. Therefore, the household count was calculated as a count of how many mail ballots were sent to the address. Adding to that is the potential problem where a voter who is not registered for vote-by-mail but lives with people who do receive a mail ballot may also mistakenly send in a family member's mail ballot believing that anyone can fill it out and send it in. This means that in addition to

counting voters with a mail ballot, I also needed to include any other registered voter without a mail ballot at the address because the potential for signing someone else's ballot is still there.

Any voter can have a signature mismatch on their own without signing the wrong envelope. Single-member households can also have signature mismatches. The question is, can I attribute an increase in signature mismatches by household to the explanation of household members signing the wrong envelope? If signing the wrong envelope is not a problem, then I should not see a significant effect by household count. The mistakes that cause signature mismatches should normally be randomized across voters. Other factors such as age, experience, and county differences should account for most of the variance (Cottrell, Herron, & Smith, 2021). One other potential problem that could also be linked to household size is a family member signing for an elderly member who has writing difficulties. If a family caretaker commonly signs documents for the elderly member, either through the power of attorney or otherwise, they may sign the ballot envelope just as they do other forms. Election administrators are also aware of this problem. 73% of the Florida ballot envelopes had some form of marking that indicated signatures as power of attorney were not allowed.

Even with family members signing for the elderly, it is still the same basic problem of someone in the household signing another person's mail ballot. Signing for elderly or disabled family members will increase the household effect, but the results can be mitigated by controlling for age. Specifically, since age normally decreases the number of signature mismatches (Cottrell, Herron, & Smith, 2021), the age at which signature mismatches begin to increase can be determined and attributed to caretakers signing for an elderly member. The remaining portion of the household effect can then be attributed to household members

mistakenly signing the wrong ballot. While the same effect from elderly and disabled family members may still overlap, the solution, adding the voter's name under the signature line, can still help resolve the problem for all household members.

Household effect vs Racial effects

Census data shows that black and Hispanics have larger household sizes (Rogers, 1996) (Statista, 2021). The larger household sizes may account for some of the ballot rejections seen in black and Hispanic voters. Household members signing the wrong ballot would not affect mail ballots being rejected for being late or unsigned, only mismatched signatures. Therefore, when analyzing the probability of a voter having a mismatched signature, the probability attributed to blacks and Hispanics should decrease once the household size is accounted for.

***H2a**: When accounting for household size, black voters are less likely to have their ballot rejected as a signature mismatch than when household size is not accounted for.*

***H2b**: When accounting for household size, Hispanic voters are less likely to have their ballot rejected as a signature mismatch than when household size is not accounted for.*

Without accounting for household size, the racial effects may pick up some of the household size effects due to blacks and Hispanics having larger household sizes. This is akin to a voting model that included racial affects but did not control for factors such as party or age. Without party or age, the differences due to party or age may be incorrectly attributed to the racial variables. Once party and age are added into the model, the amount of effect previously attributed to race should decrease since the model now attributes the effect to the more dominant party and age factors. Similarly, if other household members are signing each other's ballots, then household size could be a more dominant predictor of signature mismatches than race. If so, then once household size is added to the model, then the coefficients for race should

decrease. Comparing the analysis results for race before and after adding household size to the model will give a measure of how much of the original racial effects are attributed to the household. The difference would indicate that the analysis is correctly attributing the mismatched signatures to the household effect rather than lumping it in with racial effects. My predictions in the H2 hypotheses are that the racial effects will decrease once the household size is accounted for.

While this does not account for all racial effects on mail ballot rejections, it is helpful to explain what may be causing racial effects. If part of the racial effect is attributable to the household size, then that leaves fewer rejections that can be blamed on the racial bias of election administrators. Even if there is systemic racial bias in the system, identifying where it is coming from allows officials and researchers to focus on its causes.

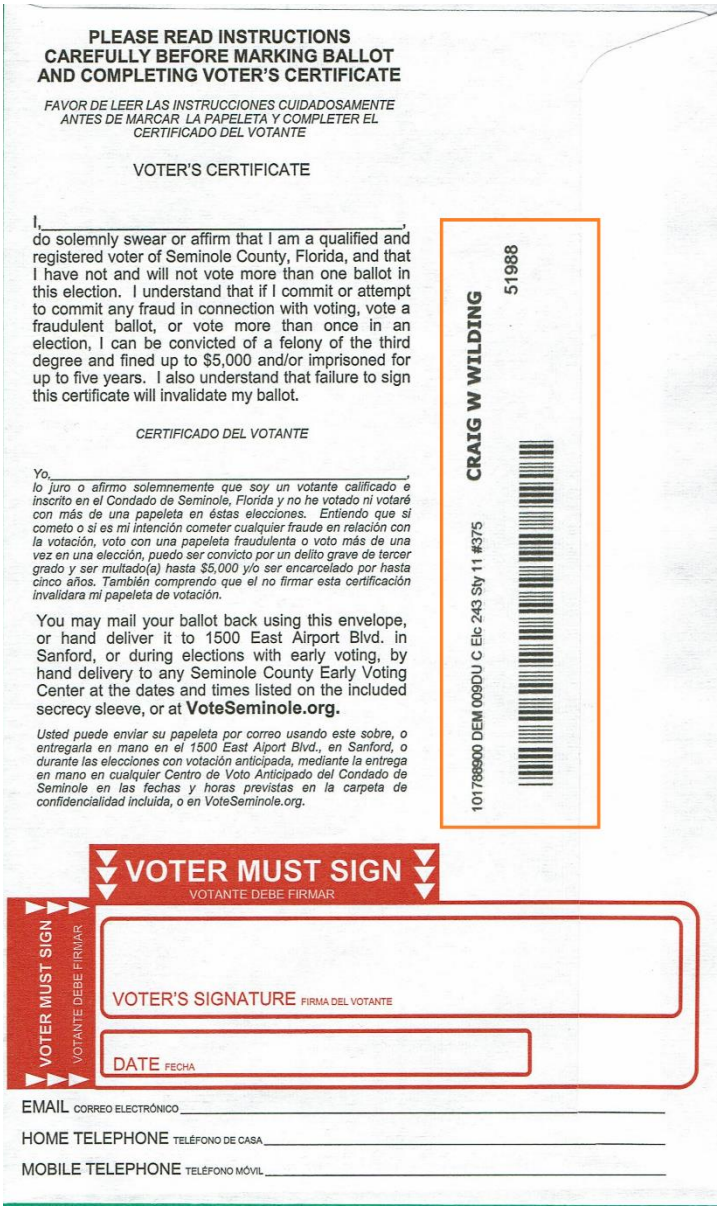
Placing the Voter's Name under the Signature Line

***H3**: In a comparison of counties, placing the voter's name under the signature line will decrease the number of mismatched signatures*

My proposed solution to the problem of household members signing the wrong ballot envelope is to place the voter's name under the signature line. Just as legal documents have the person's name or title printed below the signature line to show where to sign, doing the same in the signature area on the ballot envelope would tell household members which one of them needs to sign the ballot. This simple design change should then reduce the number of mismatched signatures. Hypothesis 3 evaluates if adding the voter's name is effective by seeing if the number of mismatched signatures decreases when the design is incorporated. Because ballot envelopes are printed and designed per county, the experiment requires an initial trial of the

design by one or more counties willing to participate. Then the before and after-effects of using the design can be measured assuming other changes are held constant.

Overall, the generic design of ballot envelopes makes it easy for voters to believe that the envelopes are interchangeable. Since the voter's name or information is not included in the required oath, instructions, or signature area, the voter can easily read through the instructions and sign the envelope without noticing that the ballot is coded to someone else. The voter's name is only included in the address area, the area outlined in orange in Figure 4, which is usually either off to one side, printed in the reverse direction as the rest of the instructions, and/or in an office-use-only area which causes it to be easily ignored (Seminole County SOE, 2020). Merging the address area with the signature area, or at least adding the voter's name under the signature line would individualize the ballot envelope so that voters can tell that it is specific to the voter and not interchangeable.



PLEASE READ INSTRUCTIONS CAREFULLY BEFORE MARKING BALLOT AND COMPLETING VOTER'S CERTIFICATE

FAVOR DE LEER LAS INSTRUCCIONES CUIDADOSAMENTE ANTES DE MARCAR LA PAPELETA Y COMPLETER EL CERTIFICADO DEL VOTANTE

VOTER'S CERTIFICATE

I,_____,
do solemnly swear or affirm that I am a qualified and registered voter of Seminole County, Florida, and that I have not and will not vote more than one ballot in this election. I understand that if I commit or attempt to commit any fraud in connection with voting, vote a fraudulent ballot, or vote more than once in an election, I can be convicted of a felony of the third degree and fined up to $5,000 and/or imprisoned for up to five years. I also understand that failure to sign this certificate will invalidate my ballot.

CERTIFICADO DEL VOTANTE

Yo,_____,
lo juro o afirmo solemnemente que soy un votante calificado e inscrito en el Condado de Seminole, Florida y no he votado ni votaré con más de una papeleta en éstas elecciones. Entiendo que si cometo o si es mi intención cometer cualquier fraude en relación con la votación, voto con una papeleta fraudulenta o voto más de una vez en una elección, puedo ser convicto por un delito grave de tercer grado y ser multado(a) hasta $5,000 y/o ser encarcelado por hasta cinco años. También comprendo que el no firmar esta certificación invalidara mi papeleta de votación.

You may mail your ballot back using this envelope, or hand deliver it to 1500 East Airport Blvd. in Sanford, or during elections with early voting, by hand delivery to any Seminole County Early Voting Center at the dates and times listed on the included secrecy sleeve, or at **VoteSeminole.org.**

Usted puede enviar su papeleta por correo usando este sobre, o entregarla en mano en el 1500 East Aiport Blvd., en Sanford, o durante las elecciones con votación anticipada, mediante la entrega en mano en cualquier Centro de Voto Anticipado del Condado de Seminole en las fechas y horas previstas en la carpeta de confidencialidad incluida, o en VoteSeminole.org.

CRAIG W WILDING
51988
101788900 DEM 009DU C Ele: 243 Sty 11 #375

VOTER MUST SIGN
VOTANTE DEBE FIRMAR

VOTER'S SIGNATURE FIRMA DEL VOTANTE

DATE FECHA

EMAIL CORREO ELECTRÓNICO_____

HOME TELEPHONE TELÉFONO DE CASA_____

MOBILE TELEPHONE TELÉFONO MÓVIL_____

Figure 4 Address Area on Ballot Envelope

Source: Seminole County SOE (2020)

Unfortunately, placing the voter's name under the signature line could have a negative effect for blacks and Hispanics. If election officials reviewing the signature identify the person as black or Hispanic it could result in discrimination that causes them to be rejected more frequently. This is in line with research experiments that change the name on a resume or information request to a black or Hispanic name which then receives fewer responses (White, Nathan, & Faller, 2015) (Bertrand & Mullainathan, 2004). For ballot signature validation, though, reducing the household effect where the wrong person signs the ballot should prevent it from being flagged as a signature mismatch and avoid manual review, thus limiting the possible discrimination later. However, only larger election offices use systems that automatically verify the signature. Most capture the signature for review by election officials. This does present an opportunity for bias to be introduced due to placing the name under the signature. While a person's often illegible signature may not indicate a person's race. The printed spelling of the name below the line could identify the person's race and trigger racial bias. This gives justification for including controls for racial effects in the experiment.

Evaluating Ballot Envelope Designs

Can the layout and design of the ballot envelope cause or reduce errors? From previous research on ballot design (Kimball & Kropf, 2005) (Ross, 2020) (Niemi & Herrnson, 2003), we know that small changes in the location of instructions, shading or highlighting areas, and using bold fonts can work together to produce a more readable ballot that produces fewer overvotes and undervotes. I can therefore expect that changes to the ballot envelope design should also help reduce voter errors. The main error with ballot envelopes is not signing them. Because there is no state-wide design for the ballot envelope in Florida, each county election

administrator has its own design. Election administrators often copy parts of the envelope design from each other. This gives some common design features that still have enough variance in usage that they can be tested for effectiveness. By determining whether existing envelope design features make a difference in reducing signature errors, I can establish a rationale that other design changes could also have an effect.

Location

To remind voters to sign the ballot, arrows are placed on the front and/or back of the envelope to draw attention to the signature area. See Figure 5. The difference in placement of arrows on the front or back gives an opportunity to validate whether the location of the arrow makes a difference. 67% of the counties have some form of an arrow on the back. This conforms with design research that recommends placing instructions nearest to where they are needed (Dillman, 2006).

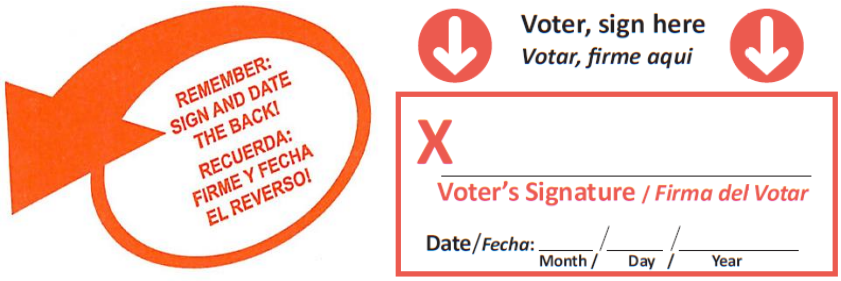


Figure 5 Arrows on Front and Back of Envelope

Source: Left: Clay County SOE (2020). Right: Bradford County SOE (2020)

Placing an arrow on the front of the envelope gives the voter a second reminder to check the signature as they place a stamp on it or place it in a mailbox. This presents an opportunity to determine whether the arrow location has a significant design effect on reducing unsigned ballots. Hypothesis 4a tests if placing the arrow on the front makes a difference. This gives us a test of how the location of information in the envelope design affects voter errors.

***H4a**: In a comparison of counties, placing an arrow on the front of the envelope to indicate they need to sign the back will decrease the number of unsigned envelopes*

Key Words

A second common feature of the envelope designs is including a warning that Power of Attorney is not allowed. If included, it was almost always included directly above or below the signature area. This allows me to test specific wording effects. Does the specific mentioning of power of attorney reduce the number of signature mismatches? Hypothesis H4b predicts that it will. This also acts as a control in the study because family members or caregivers signing for an elderly person under power of attorney would also add to the household size effect on mismatched signatures. Testing the effect of the power of attorney warning, therefore, controls for the number of signature mismatches reduced by using the warning in the design.

***H4b**: In a comparison of counties, placing a warning that Power of Attorney is not allowed will decrease the number of mismatched signatures*

Layout

The third envelope design feature I looked at was the layout of the signature box itself. The design in Figure 6 has a distinctive red box that highlights and draws attention to the signature area (Seminole County SOE, 2020). It was used in a consistent manner by one-third of the counties. Other counties varied from a Microsoft Word style table to a plain signature line

after the oath and instructions. This presents an opportunity to determine whether the layout does better at reducing the number of unsigned ballots. For testing, hypothesis H4c predicts that the more distinctive red box layout will reduce unsigned ballots more than the table design.

***H4c**: In a comparison of counties, using the red box layout will decrease the number of unsigned envelopes more than the table layout*

Figure 6 Red Box Layout for Signature Area

Source: Seminole County SOE (2020)

In conclusion, testing the features of the existing ballot envelope designs is a way to determine whether design changes are effective or not. If effective, it will lend support to the idea that changing the envelope design to place the voter's name in the signature line should also be effective in reducing the household size effect on mismatched signatures. This will help election administrators evaluate whether making the design change is worth the effort.

DATA AND METHODS

Data from the Florida 2020 general election was used for this study. Florida has sunshine laws that make the voter registration records open to the public and at no cost. This makes it easier for researchers to obtain the data. Florida is the third-largest state, with 15 million voters and 6 million mail ballots in 2020. The pandemic caused a huge influx of voters switching to or at least requesting a mail ballot. This influx of new vote-by-mail users also increases the likelihood of mistakes being made in returning the ballot (Cottrell, Herron, & Smith, 2021). Using the 2020 Florida general election, therefore, combines a large dataset capable of finding rare mistakes along with an increased likelihood of such rare mistakes happening. Other states, such as California or New York, would be equally valid to use being similar size or larger. However, I intended this research to follow up on claims made about racial bias in mail ballot voting made by Smith (2018) so I used the Florida voter registration and mail ballot status that was used in that research and follow-up research (Cottrell, Herron, & Smith, 2021) (Baringer, Herron, & Smith, 2020) to be consistent.

Voter Registration and Mail Ballot Status

Data on the mail ballots that were sent out in the 2020 general election was retrieved from the FL DOE. Each county reported a daily status of ballots sent and received from the day they began to send out mail ballots on Oct. 5, 2020, to fifteen days after the election on Nov. 18, 2020. These files have the voter ID, county, mail address used, and ballot status of each voter who was sent a ballot. Florida voter registration information is publicly available upon registration with the FL DOE and monthly disks of voter registration and voter history information are distributed. The list of voters was pulled from the November 2020 disk. The

November disk was used because it would include anyone who registered for the general election by the book closing date. The voter file has the registered address and mailing address of the voter. Using the November voter registration file also ensures that the addresses in the voter registration file are closest to the addresses from the mail ballot status files.

Table 1 VBM Status Codes

CODE	NAME	DESCRPTION
C	Cancelled	Used if the voter moved to a different county or if they requested the mail ballot to only be sent for the current election. In the latter case, the status can change to c even after it was recorded as voted.
E	Voter Error	Used to indicate a mismatched signature
N	Unsigned	The mail ballot was returned unsigned
P	Provided	Means it was mailed out, but the voter has not yet returned it. This identifies the date the mail ballot was sent out.
R	Requested	The voter will be sent the mail ballot when sent out. All votes with an active vote by mail request start in this status and are moved to Provided when the mail ballots are sent out. If a voter requests a mail ballot after the 10-day deadline before the election, they are added as Requested for the next election.
S	Standing	
U	Undeliverable	The mail address was returned as undeliverable. Mail ballots are non-forwardable, so if the post office no longer has the person registered at the address, then it is returned to the SOE as undeliverable.
V	Voted	The mail ballot was returned and was successfully counted.

VBM Status Codes

The mail ballot status files contain a status code indicating the ballots sent and returned status. Table 1 gives the list of status codes used in the file. What I specifically looked at was the E status for Voter Error. Since N accounts for all unsigned mail ballots, mail ballots that had a signature that did not match should be indicated by error code E for Voter Error. While voter error may also include duplicates or people that died, these cases are rare (Burden & Gaines, 2013) so I counted all mail ballots with the E status as a mismatched signature. Counting duplicates and deaths as mismatched signatures could make the results slightly higher than the actual values. Fourteen counties reported no mismatch errors. They were all under 10,000 mail ballots total which would be statistically viable given the low rate of signature mismatches. Of these, four of the counties, Baker, DeSoto, Hamilton, and Hardee also reported no missing signatures or late ballots either. Each of these counties has under 3,500 mail ballots each. Due to their smaller size, they may have been able to correct any errors without reporting them. This difference in reporting was controlled for by using county fixed-effects and clustering.

Late Ballots

If the ballot arrived after the election, I assumed that the error flag indicated that it was late rather than a mismatched signature. There are two deadlines: 11-3-2020 for civilian ballots and 10 days later, 11-13-2020, for military, overseas, or military dependents. Ballots that had a return date after the deadline were marked as late. This overrides any other status such as unsigned or mismatch. In some cases, the return date was not available for all records. The files for Sarasota County had bad return dates. In this case, I used the Error Date, which is the date the error was reported. Some records may have a status code or return date that conflicts. In this

case, the voted status was given top priority, followed by late, and then a status that indicated either unsigned or mismatched. This is the coding methodology used in Cottrell, Herron, & Smith (2021).

Errors In versus Errors Unresolved

Because the mail ballot status files are cumulative for any voter who was sent a mail ballot, the status changes between the daily files. By collecting all of the daily reports, I was able to get a count of all mail ballots that were ever rejected, rather than only those that remained unresolved. There is a mail ballot cure process for people to correct signature or other problems with their ballot. If the voter cures their ballot, the final report will show the status as voted rather than voter error. Because I want to determine whether there is a household size effect causing mismatched signatures, I need to look at all of the errors coming into the elections office, not just the ones that remained unresolved. Therefore, the count of mismatched ballots that I use includes any ballot that was ever flagged as a mismatched signature. This is different from most other studies that only examine the unresolved ballots (Baringer, Herron, & Smith, 2020) (Cottrell, Herron, & Smith, 2021) (Shino, Suttmann-Lea, & Smith, 2021).

Householding

The first question to answer about determining household size is whether to include only voters who received a mail ballot or to include all voters at the address. It is possible that voters without mail ballot requests may incorrectly return a mail ballot sent to another household member. For example, there was a case presented to a canvassing board where a provisional ballot claimed that the father had mistakenly submitted the son's mail ballot believing it was his. This shows a plausible condition where other voters in the household can incorrectly sign or

submit another household member's ballot. Even if the father had not registered to receive a mail ballot, he might reasonably believe that he had and send in any mail ballot received at the household. Therefore, I included all registered voters at the address in the household count. This would account for someone else in the household mailing someone else's ballot by mistake.

Mail ballots are frequently sent to an address other than the registered address. This is commonly used by college students voting away from home, voters who are out of town on election day, people who live part of the year in another location, military members, or civilians overseas. Having a different mailing address affects the household count. The household count indicates how many voters are at an address. If the mailing address is different from the registered address, then the assumption is that the voter is at the mailing address and not the registered address. The mail address from the VBM status files was added to the household count first, then the registered address of any voter who did not receive a mail ballot was added to the household count at that address. In total, there were approximately 225 million daily VBM status records that were analyzed to determine if any of the 6 million voters with VBM was ever flagged as a signature mismatch. The 6 million VBM addresses were then matched along with an additional 15 million addresses from the voter files. Of the 6 million that were sent a mail ballot, only 4.9 million returned a ballot.

Public Institutions

Addresses of public institutions such as universities, jails, rehabilitation centers, and SOE offices are excluded from household counts. These are identified by having a household count

over 10. If students at a university have unique addresses, then they are included. When a single mail address is used across a university or campus, such as the University of Tampa which had 106 mail ballots all going to the same address, then they were excluded after exceeding the 10-person limit. The SOE address is commonly used for homeless citizens as well as rehabilitation centers. These institutions act as places where homeless citizens can receive mail.

The method that the mail ballots are distributed at public institutions is likely to differ significantly from a household address. My assumption for a household is that there is a 'stack of mail ballots lying on the table' where residents may or may not grab or sign the correct one. If the distribution method at public institutions is more controlled, then it may remove the possibility of signing the wrong ballot upfront. I, therefore, excluded them as being in a different environment than the rest of the study.

Senior Homes

I created a separate category for senior homes. If there were 10 or more voters at the address and all were age 65 or over, the address was flagged as a senior home. This uses the date of birth to determine the age of each voter at the residence. These were excluded from household counts for the same reasoning stated for removing public institutions.

Address Matching

To count the number of people in a household, I needed to match the addresses and count the number of voters at each address. I used two methods to match addresses. The first method did a direct string comparison between addresses. It compared the three address lines, the city, state, zip, and country if available. If any address was spelled incorrectly or spelled differently,

then the addresses would not match. To enhance the matching process, the second method used an address parser to break the address into its components, such as street number, direction, name, and type.

Standardization

I changed the addresses to use standard abbreviations. This way, the addresses are more likely to match each other. For example, the addresses 10 EAST GLEN STREET and 10 E GLEN ST do not match under a direct string comparison, even though those are the same addresses. By changing them to use standard abbreviations, they would then match, and the household counts were more accurate. Standard abbreviations (and misspellings) were retrieved from the USPS (USPS, 2021). Examples of standard abbreviations are AVENUE → AVE, APARTMENT → APT → UNIT, and street directions being abbreviated to N, S, E, W, NE, NW, SE, SW

Parsing

I used the python module, US address, to parse the address into its component pieces. This allowed me to do a direct comparison of each component, which is more accurate than the unformatted address. For example, the addresses 10 E GLEN ST and 10 GLEN ST E do not match under a direct string comparison, even though those are the same addresses. By changing them to use standard abbreviations, they then match, and the household counts can be more accurate.

Differences in Address Matching Methods

After standardizing and parsing the addresses, more addresses were able to be correctly matched. The mean household size increased from 1.67 to 2.08 using the standardized addresses. This difference in means from a two-tailed t-test is significant with a p-value of 0.000 that the mean from the standardized method is greater than the original mean. Because the standardized method more accurately matched addresses, I used the household size counts from the standardized method.

Designing a Ballot with the Voter's Name under the Signature Line

I came up with a ballot design that included the voter's name in the signature area (Figure 7). This design moves the red signature box to be around the area where the voter's name, address, and barcoded information are printed for mailing. The barcode has to show through a window on the outgoing envelope for it to be processed by the USPS. This means the barcode has to remain where it is, and the rest of the design has to be moved around it. The design also changes the layout from the portrait orientation in Figure 4 to landscape orientation. This change in orientation may be more difficult for some election offices.

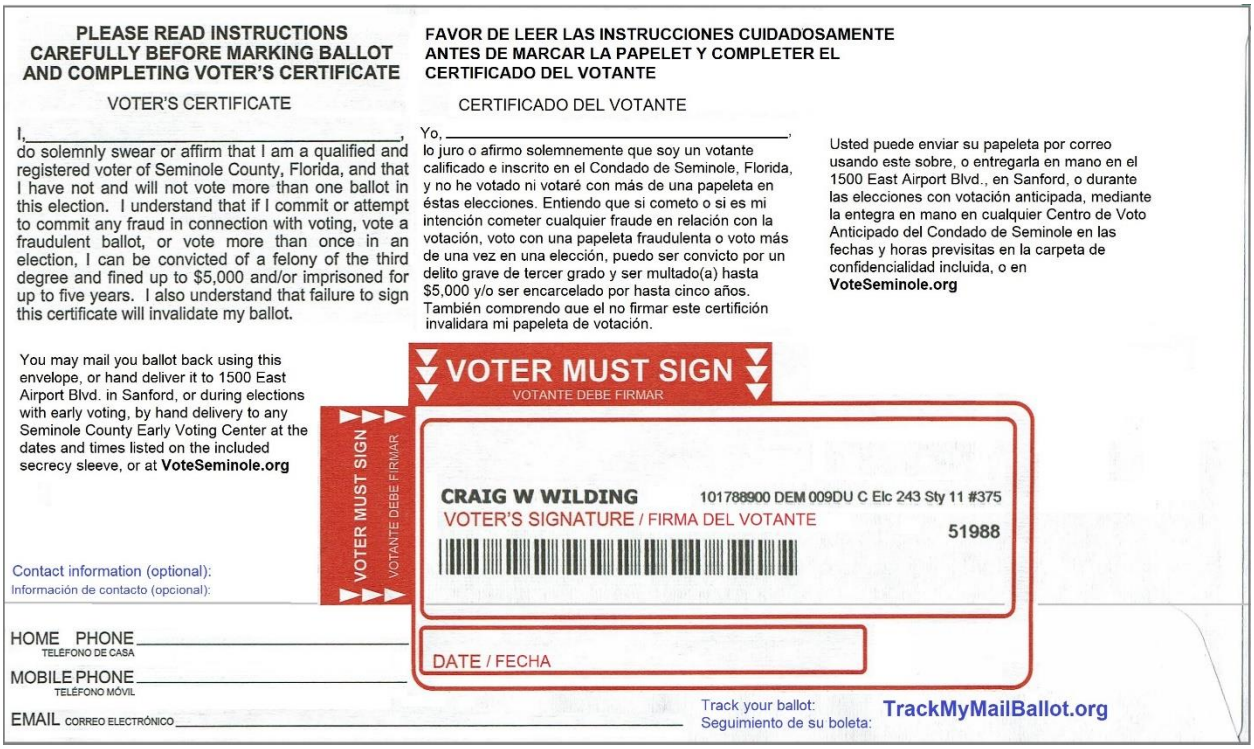


Figure 7 Envelope Design with Voter's Name by Signature

An alternative would be to leave the signature box where it is and print the voter's name under the existing signature line. The Center for Civic Design (2017) ballot shown in Figure 8 includes an example envelope design that printed the voter's name under the signature line. The problem with printing the ballots with the voter's name on the original signature line is that it prints the name twice on the ballot envelope. There is no legal issue with this, but normally the non-identifying information, such as the oath and signature line is preprinted generically on the ballots first. The voter's name and address are printed on the ballot envelope later. This makes it difficult for the two to remain in sync. The second print pass where the voter's name is printed could potentially misalign with the signature line. This may not only require a design change, but also a change in the envelope printing process.

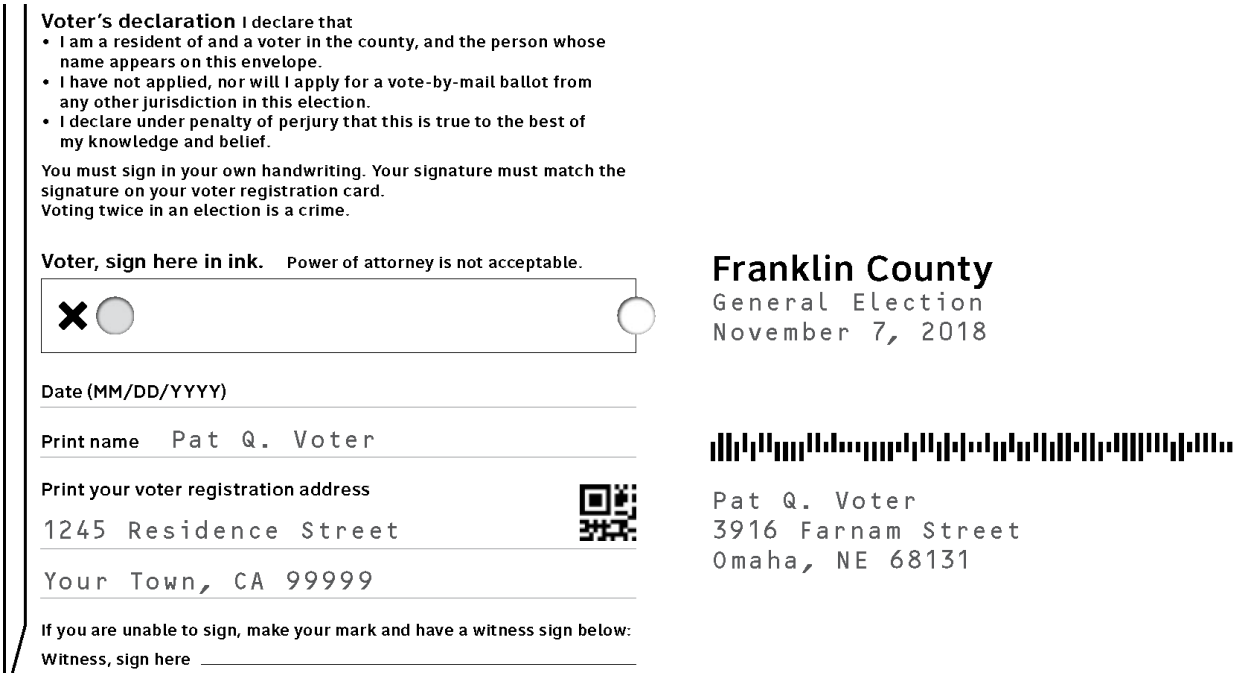


Figure 8 Envelope Design with Voter Name by Existing Signature Line

Source: Center for Civic Design (2017)

A third procedural problem arises when changing the location of the signature line. Especially from portrait to a landscape orientation or vice versa. The device that scans the signatures off of the ballot envelope would need to be adjusted to target the new signature area and possibly rotate the scanned image if the orientation changed. The signature scanning devices should be able to adjust to a new area. Given the wide variety in the current designs of the signature boxes and their location, this gives evidence that the scanning devices can be adjusted, but there may be some limits. It is more of a question of whether election administrators would be willing to adjust their system to try a new design.

What became evident is that I could not just change the ballot envelope design without considering the entire process of how they are printed, mailed, and scanned in for counting. This

proved to be another obstacle to running a test of the proposed ballot envelope design change. Besides presenting the visual design, it would require ensuring the election administrator's printing and scanning systems could process the new design. As a result, testing of hypothesis 3 was excluded.

Ballot Designs

For testing mail ballot envelope designs, I requested a copy of the ballot envelope from the 2020 general election from each of the 67 Florida counties. 64 of the 67 were returned. Gadsden, Hardee, and Monroe counties did not reply. Their reported VBM totals were 7,727, 1,668, and 22,894 respectively putting them at the smaller end of the scale. Some counties have a different envelope for civilian and UOCOVA voters that note the different rules and extended deadlines allowed for military and overseas voters. In this case, the civilian envelope was used in rating the envelope designs. The envelope designs were rated on criteria to evaluate hypotheses 4 a-c. I also counted the number of languages printed on the ballot envelope. Having to print instructions in multiple languages can reduce the amount of space available on the ballot envelope, which in turn can restrict the ability to add some of the ballot features, such as arrows. Counting the number of languages provides a control measure for determining whether language requirements are reducing the ability to add design features. The Voting Rights Act requires minority languages to be provided if a minority language group exceeds either 10,000 voters or 5% of the voting-age population (Department of Justice, 2020). 76.5% of the counties required both English and Spanish on the envelopes. Broward and Miami Dade had three languages.

Arrow Front

I rated the envelope design on whether it included an indication on the front side that voters needed to sign on the backside. Because there is some variation on the indication, I made it scalar rather than binary, with zero being no indication and going up to three depending on how much attention the notice gathered. While I was looking for an arrow as in Figure 10, I scored them on any notification, either text or graphic with higher scores based on how much attention it draws from the reader.

Minor Indication:

If the front of the ballot contains a note to sign the back, normally under the return address area as in Figure 9, then I scored it as having a minor indication. The voter may not notice it.

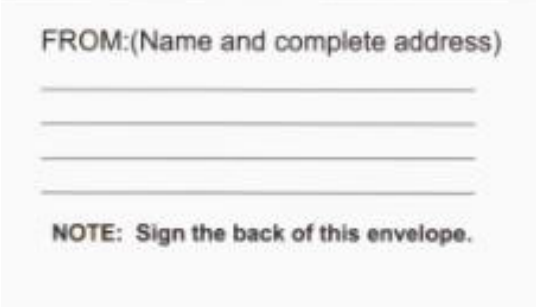


Figure 9 Arrow Front Minor Indication

Source: Baker County SOE (2020)

Major Indication:

If the front of the ballot contains the arrow on the front as in Figure 10 (left), I scored it as a major indication. If it did not have the arrow as in Figure 10 (right) but gets the voter's attention by being in the same placement area, then I also scored it as having a major indication.

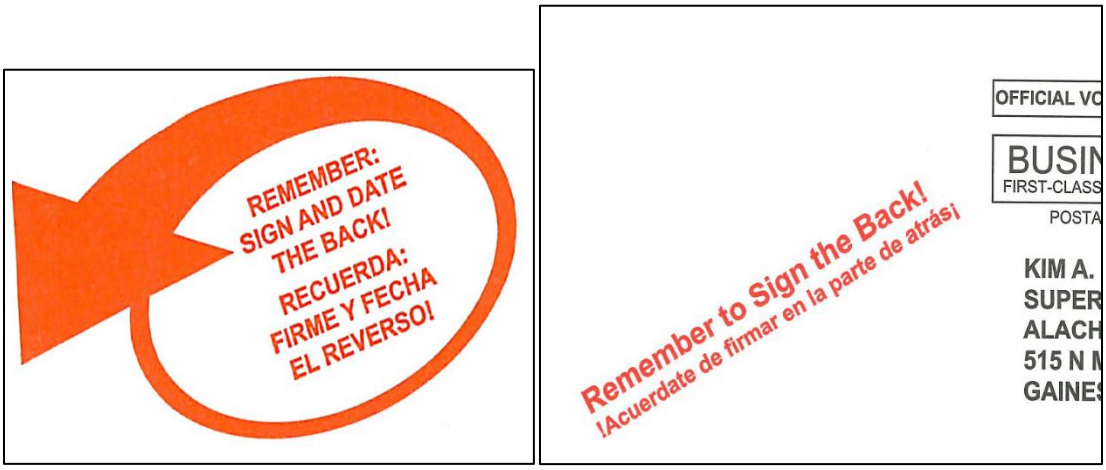


Figure 10 Arrow Front Examples of Full Indication

Source: Left: Clay County SOE (2020). Right: Alachua County SOE (2020)

Extra Indication:

Some counties gave even more notice, such as including giant stop signs or extra flaps on the envelope dedicated to making sure the voter signs the ballot. These were given a top score of three.

Figure 11 Extra Indication for Signature

Source: Brevard County SOE (2020)

Arrows on Back

I rated the envelope design on whether it included an arrow, stop sign or other symbols on the backside that draws attention to the signature. This will be used in conjunction with the front side indicator to see if one or the other works better, or if the effect requires both. Because there is some variation on the indication, I made it scalar rather than binary.

Minor Indication:

If the back of the ballot contains an arrow to sign the back, but its placement is not significantly large or different from the signature area, then I scored it as having a minor indication. The voter may not notice it. Figure 12 shows examples of designs considered minor. Normally, there is an arrow, but it blends in with the signature box. Most envelopes fall into this

category because they do not have space for a larger arrow, especially if they have to accommodate a Spanish translation.

Figure 12 Minor Arrow on Back

Source: Left: Seminole County SOE (2020). Right: Bradford County SOE (2020)

Major Indication:

If the back of the ballot contains an arrow to sign the back, and its placement is significantly large or different from the signature area, then I scored it as having a major indication. The voter should notice it.

Figure 13 Major Arrow on Back

Source: Calhoun County SOE (2020)

No Indication:

Some envelopes do not give any arrows or other notifications on the envelope other than the signature line itself. Figure 14 gives examples. Note that by being outlined in red, it still stands out, but for study purposes, this is considered the default.

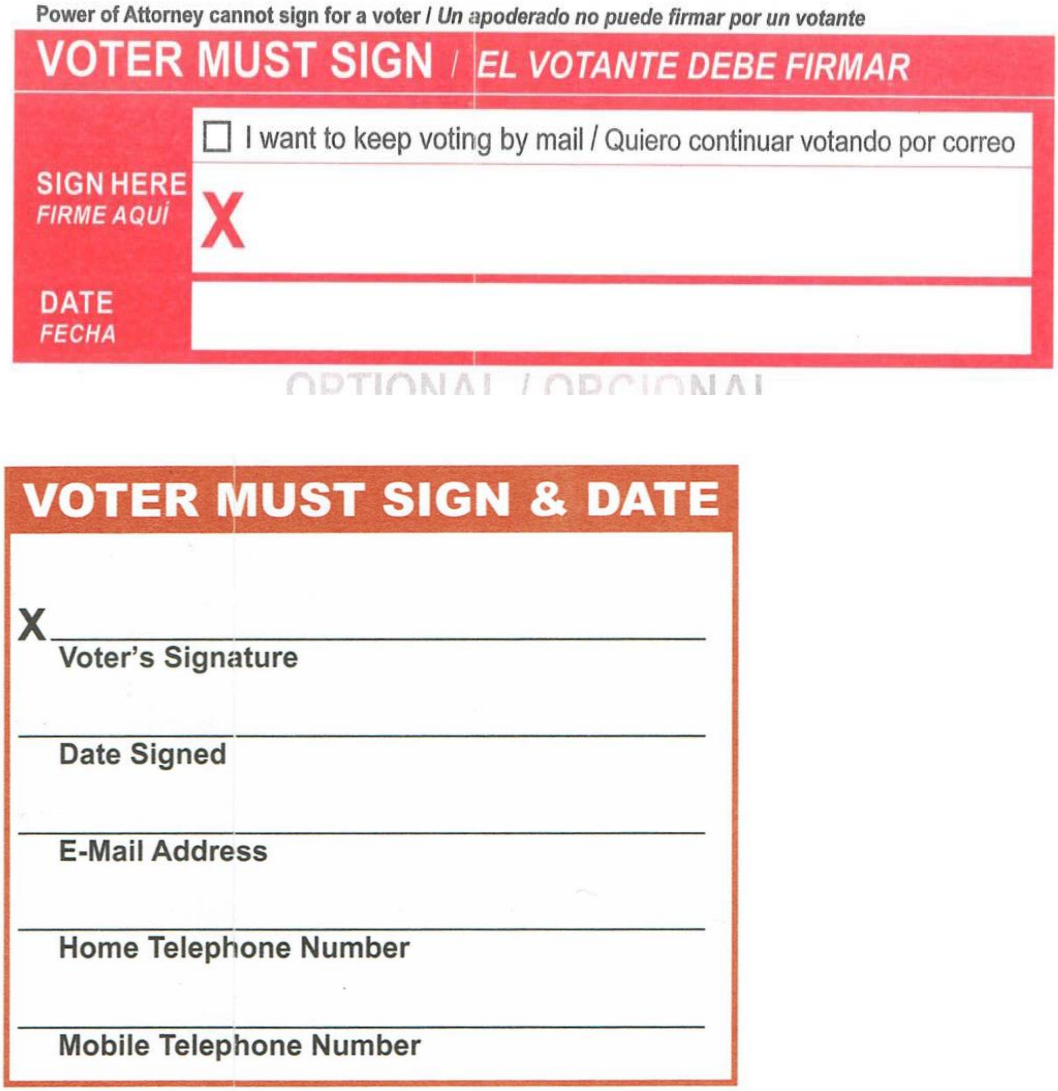


Figure 14 No Arrow on Back

Source: Top: Hillsborough County SOE (2020) Bottom: Baker County SOE (2020)

Power of Attorney

Some envelopes include a notice that power of attorney is not allowed. This could affect older or disabled voters who normally have a person with power of attorney signing documents for them. If the attorney signs for them, it would be considered a signature mismatch and be recorded as a signature mismatch.

Full / Minor Indication:

Full indication, in this case, means that the notice was placed near the signature box where the voter or attorney is most likely to see it when signing. Minor indication means the notice was placed elsewhere on the envelope, such as being placed with other instructions. In this case, the attorney may not see it when signing or may not read all parts of the envelope.

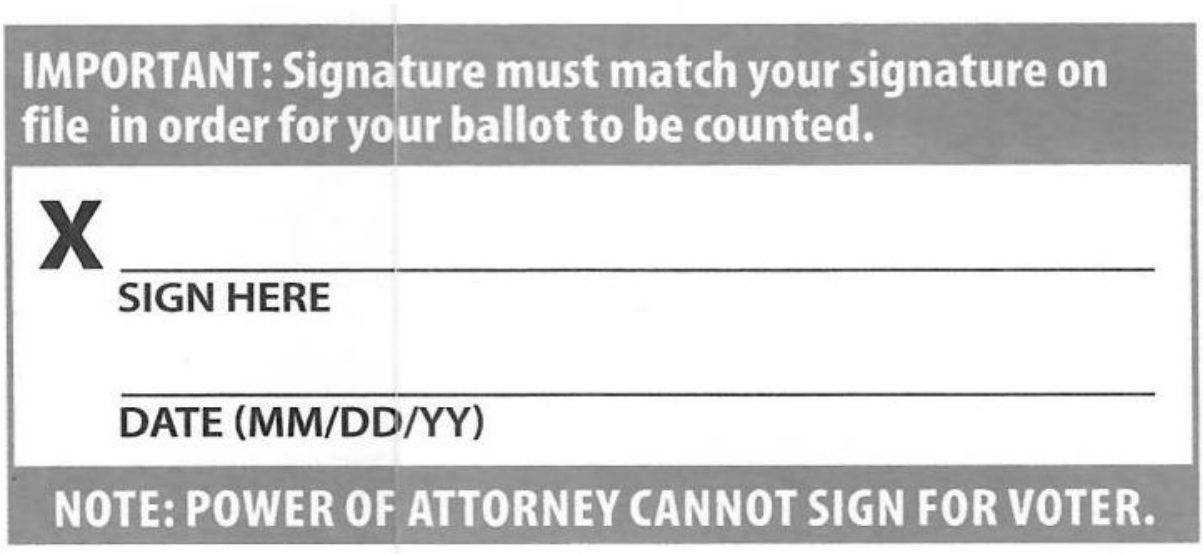


Figure 15 Power of Attorney - Full Indication

Source: Calhoun County SOE (2020)

Figure 16 Power of Attorney - Minor Indication

Source: Citrus County SOE (2020)

Red Box Layout

For Hypothesis 4c, I indicated whether the signature area used the more distinctive red box layout seen in Figure 6. About one-third of the counties use the red box design with little variation. Since the red box design stood out and was consistently used, I measured its usage for layout effects. Like the arrows, the red box is more attention getting and identifies the part where the signature is required, therefore my expectation is that it will reduce the number of unsigned ballots by drawing attention.

County Statistics

Because ballot envelope designs are per county, I combined them with aggregated counts of late, unsigned, and mismatched signatures by county from the mail ballot and voter registration data detailed above. I also collected statistics on the number of registered voters, the number of mail ballots sent, and the voter turnout by county from the FL DOE. Of these, I used the number of mail ballots as a control variable to account for the scale of mail ballots the county processed. Counties processing more mail ballots are likely to have more sophisticated

procedures than smaller counties (Alvarez, Hall, & Sinclair, 2008) or may have more budget to allocate to more sophisticated ballot designs. The number of mail ballots worked better as a control variable than the registered voter count since the dependent variables require a mail ballot to be sent for them to occur.

RESULTS

The pandemic caused a huge influx of voters switching to vote by mail. Mail ballots increased from 2.7 million in 2016 to 4.8 million counted ballots in 2020. Democrats and NPAs both doubled their mail ballot usage while Republicans only increased vote by mail usage by 36% (FLDOE, 2020). This indicates that distrust of vote by mail among Republicans had a visible impact even with the pandemic. The resulting dataset of 6 million mail ballots is potentially large enough to produce statistically significant results even though there is no meaningful relation between variables. Because household size is not expected to have as large of an occurrence rate as other factors, a large dataset was necessary to determine how frequently it occurs. However, to prevent potential false reporting, results were not considered significant if lower than the p=.001 level.

Household Size Effect

The first question to answer is whether there is an identifiable household size effect on mismatched signatures. I ran a probit model to predict the likelihood of having a mismatched signature controlling for age, race, party, mail ballot history, and mail zone. I used fixed-effects for the county, and clustering errors by county since the county is repeated in the dataset and it accounts for differences between counties. The probit model was used over the logistical model so that I could later use a Heckman probit model to predict the likelihood of a signature mismatch if all voters had returned a mail ballot. Figure 17 shows the probability of having a mismatched signature increases steadily as the household size increases, as expected. The base probability of the signature not matching for an individual with no one else in the household is 0.009%. This indicates the low baseline probability of a signature mismatch occurring at all. At

this rate, an election administrator could expect 9 mismatched signatures per 100,000 ballots. This low baseline probability emphasizes the need to use a large dataset to find a change in something that has a low occurrence, to begin with.

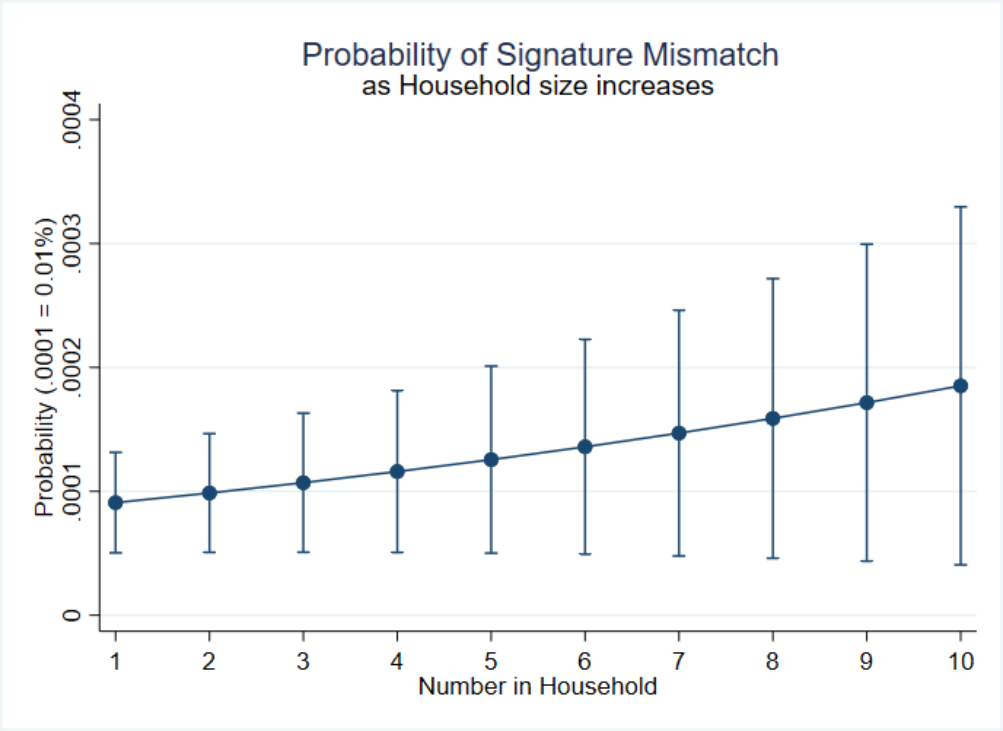


Figure 17 Mismatched Signatures by Household Size

The probability increases to 0.00986% with the addition of a second household member and goes up to 0.01851% at 10 people in the household. More importantly, the probability steadily increases as the household size increases. The probit analysis confirms that the effects of household size are significant at a 99.9% confidence level, which confirms hypothesis 1 that signature mismatches increase as household size increases. There is a significant correlation.

Figure 17 shows the 95% confidence interval grows wider as household size increases. This is expected since there are far fewer households with five or more members. This gives

more uncertainty of the true probability in larger households. However, the confidence intervals never exclude the starting interval at one person in the household. It is possible that the errors seen at larger household sizes are still due to the error rate of a single individual and thus not related to being in a household. I ran a t-test to compare the means between a single-member household and those with a household size of two or more. The t-test confirmed that the mean number of signature mismatches for households with two or more people was significantly greater than single-member households. The difference is significant at the 99.9% confidence interval and the confidence intervals between single-member homes and households with two or more do not overlap. The increase in signature mismatches is therefore attributable to having additional household members, not solely from the odds of one person having a mismatch. To state that another way, if you selected a household with three people in it, you would see more signature mismatches than from selecting three individual people.

Table 2 Probit Regression of Signature Mismatches

probit	*Probability of Signature Mismatch*			
variable	*Probability per unit change*	*Robust std. error*	*z*	*Probability per 1 SD*
household	0.02240%	.0066527	4.01	0.04101%
black	0.10881%	.0194233	6.67	0.05836%
Hispanic	0.09654%	.0197932	5.80	0.05888%
age	-0.02230%	.0019978	-13.28	-0.37153%
age^2	0.00016%	.0000158	12.34	0.92691%
VBM History	-0.02167%	.0021866	-11.79	-0.14198%
gender(female)	-0.08271%	.0098758	-9.97	-0.06093%
NPA	0.04024%	.0093685	5.11	0.02792%
mail zone	0.16550%	.0349056	5.64	0.12813%
constant			-29.59	
N	4,706,500			
Pseudo R^2	0.1376			

Errors clustered by county. All results significant at 99.9% confidence level

While small, the increase in signature mismatches from household size is comparable to other variables. From calculating the standardized probabilities shown in Table 2, age and mail ballot history are the largest influencers on signature mismatches, both of which decrease the probability. The change from household size, while not the largest, is comparable to that of blacks, Hispanics, and females. It is also surprisingly larger than party effects in terms of change per standard deviation. Party effects were measured as NPA vs Democrat or Republican. The implication was that by not getting information or instructions from the party, NPAs had more signature errors. If having instructions available for party members decreases their error rate, then identifying the voter's name on the envelope to prevent a household member from signing the wrong ballot should have as much or more effect than party affiliation. Each of these, while

significant, are all just fractions of a percentage in differences. This emphasizes the fact that signature mismatches are normally rare, to begin with, so I am looking for small marginal increases or decreases that add up over a large scale. Fewer mail ballots having to go through the cure process after a signature error can reduce staff costs for election officials, allow quicker reporting of election results, and ultimately affect the outcome of close races.

Reversal in Age Effects

The previous literature treated age as a set of increasing age categories (Smith, 2018) (Baringer, Herron, & Smith, 2020) (Shino, Suttmann-Lea, & Smith, 2021). Each of these found that each increasing age group reduced the probability of late ballots, unsigned ballots, and mismatched signatures. I found a similar trend but expect there to be a cut-off point where signature mismatches begin to increase as one gets older and writing becomes more difficult. To detect this, I added age squared to the regression. This creates a quadratic equation for age effects that follow a hyperbolic curve. The curve peaked at age 72, with signature mismatches decreasing up to that point, then increasing again after that age as displayed in Figure 18. Both age and age squared were significant in regression analysis, indicating the drop-off at age 72 is an equally significant effect as the decreasing effects on age before that. This also supports the theory of older voters having writing difficulties or using other household members or caretakers to sign the ballot for them. Both of these would cause a signature mismatch for older voters.

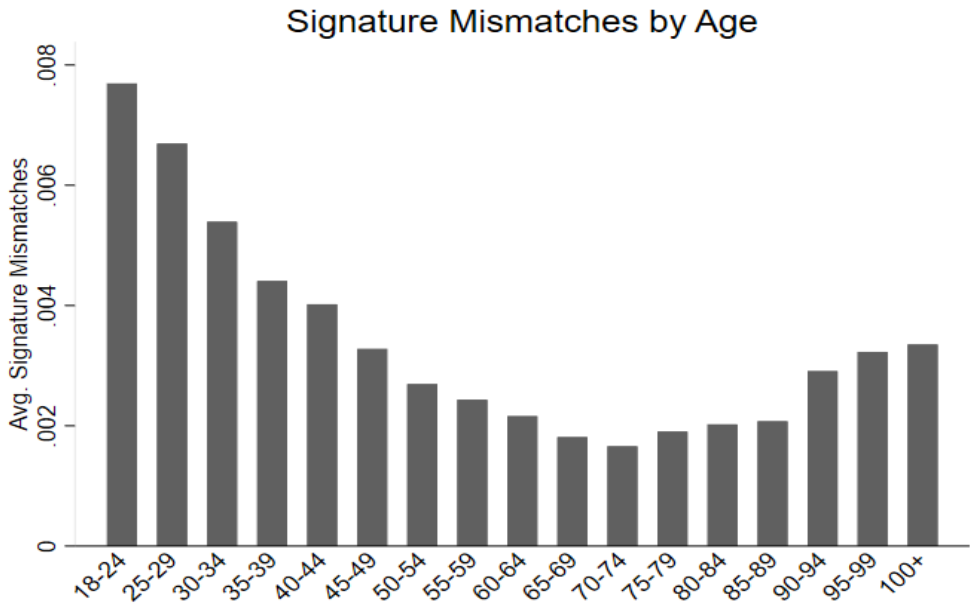


Figure 18 Signature Mismatches by Age

Age versus Vote-by-Mail History

Cottrell, Herron, & Smith (2021) added a measure for the amount of experience a voter had in using mail ballots. They counted someone as experienced using mail ballots if they voted by mail in the previous two general elections. Inexperienced voters voted in person in the previous two general elections before switching to using a mail ballot. They found that inexperience significantly increases late and unsigned ballots in addition to age effects. Specifically, young voters, both experienced and inexperienced had higher rates of late ballots than older voters (Cottrell, Herron, & Smith, 2021, p. 20). This shows that age does not equal experience or vice-versa. The two variables cannot be substituted for each other. Instead, they can both be added as independent variables measuring different concepts.

Cottrell, Herron, & Smith (2021) uses a short-term measure for experience. Since the Florida voter files include a complete voter history since the voter registered to vote in Florida, I created a long-term history of mail ballot experience to use. The voter history marks how the person voted in each election, either in person, by mail, or through early voting. It also marks if the mail ballot was approved or rejected. I counted all instances of voting by mail for the voter, both successful and unsuccessful. I figured that unsuccessful attempts would either help voters correct their mistakes if they continued voting by mail, or they would switch to in-person voting and have less mail ballot experience. This total mail ballot count gives a long-term measure of VBM experience. My results are similar to Cottrell, Herron, & Smith (2021). The long-term measure of VBM experience had independent effects apart from age, and experience decreased the probability of mismatched signatures. This shows both long-term and short-term measures of experience returned the same results.

Household effect vs Racial effects

The second part of the study was to determine if racial effects coincide with household effects. The assumption is that blacks and Hispanics have larger household sizes, therefore the household size could be contributing to signature mismatches found by race. Hypothesis 2 predicts that the percent of signature mismatches attributed to blacks or Hispanics should decrease once the household size is accounted for. First, though, I need to verify whether blacks and Hispanics do have larger household sizes.

The Florida voter registration file uses nine categories for race. I condensed it down to four categories: white, black, Hispanic, and other. I created dummy variables for black and Hispanic since I was specifically interested in those. The histogram in Figure 19 gives a clearer

picture of the distribution of household size by race. Whites have a higher percentage of single or two-person households and a sharp drop-off at three or more. Blacks, Hispanics, and other races have a more gradual drop-off of larger households.

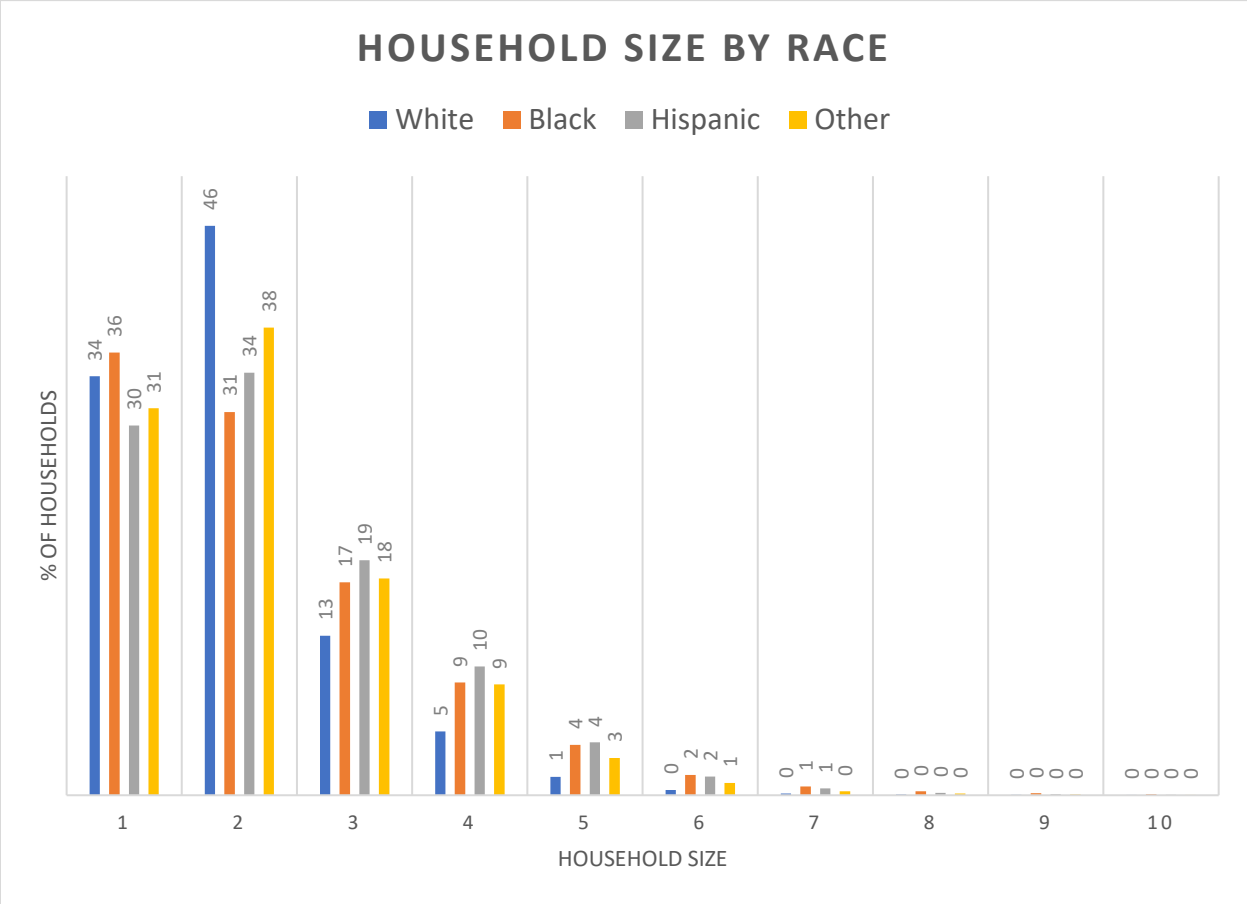


Figure 19 Household Size by Race

It would be more accurate to say that whites have fewer people in the household than to say that any other race has more per household. The drop-off rate for non-white households is fairly similar whereas there is a sharp drop for white households starting at three or more. Running a regression analysis between household size and black or Hispanic does confirm that the difference in size compared to white households is significant at the 99.9% confidence

interval with Hispanics having slightly larger households than blacks. This confirms the base assumption that blacks and Hispanics have larger household sizes.

The next step is to determine if this larger household size accounts for some of the signature mismatches being attributed to race. To test this, I ran a probit regression analysis using two models. The first excluded household size to get a baseline effect for black and Hispanic on signature mismatches. The second model then adds household size as an additional independent variable to see if the black and Hispanic variables either drop their significance level or drop the coefficient value.

Table 3 Race effects on signature mismatches

probit	*Probability of Signature Mismatch*						
	Without Household			**With Household**			Difference
variable	Probability	St. Err.	z	Probability	St. Err.	z	
household				0.02240%	.0066	4.01	
black	**0.11457%**	.0190	7.12	**0.10881%**	.0194	6.67	**0.00576%**
Hispanic	**0.10149%**	.0201	5.99	**0.09654%**	.0197	5.80	**0.00495%**
age	-0.02324%	.0021	-12.81	-0.02230%	.0019	-13.28	-0.00094%
age^2	0.00017%	.0000	12.37	0.00016%	.0000	12.34	0.00001%
VBM history	-0.02170%	.0021	-11.75	-0.02167%	.0021	-11.79	-0.00003%
gender(F)	-0.08405%	.0102	-9.71	-0.08271%	.0098	-9.97	-0.00134%
NPA	0.03934%	.0091	5.11	0.04024%	.0093	5.11	-0.00090%
mail zone	0.15571%	.0362	5.09	0.16550%	.0349	5.64	-0.00979%
constant		.0746	-23.68		.0625	-29.59	
N	4,724,484			4,706,500			
Pseudo R^2	.1366			.1376			

Errors clustered by county. All results significant at 99.9% confidence level

The results in Table 3 show that the significance level does not change. Black and Hispanic remain significant at the 99.9% confidence level along with the other control variables.

The drop in probability for black and Hispanic, highlighted in the box in Table 3, is minimal at only a .005 point drop in the percentage of probability. The differences in the other control variables are likewise slim and at times in the opposite direction. These changes in coefficients without major changes in z-score or p-values indicate that household size does not explain some of the effects of blacks and Hispanics, rather household size is its own independent variable that has been taken out of the error term of the first model.

Placing the Voter's Name under the Signature Line

I was unable to perform a study that tested whether placing the voter's name under the signature line reduced the number of mismatched signatures. This would require cooperation with one or more of the county Supervisors of Elections to design and print the ballots. There were city and local elections during 2021, but I needed to have an approved design months before the election in order to get them printed before the deadline to send them to voters. Before getting cooperation from election administrators, I need to make a convincing argument that the problem of household members signing the wrong ballot is a real and significant problem. That is what the first part of this project is intended to do. The second part of running the ballot design experiment is expected to be done after finding evidence of the problem.

Ideally, getting cooperation from one of the election administrators to use the design would lead to doing a difference-in-differences test where the new ballot design would be the treatment and differences in the rate of signature mismatches would be the treatment effect. the remaining counties would be the control group to compare against.

Ballot Envelope Designs

To validate whether changing the ballot envelope design would have any significant effect, I designed three tests that categorized design features by location, keywords, and layout. The location regression tested whether placing an arrow on the front of the ballot to warn the user to sign the back reduced the number of unsigned ballots. The second regression on keywords tested whether placing a worded notice about power of attorney not being allowed reduced the number of mismatched signatures. The third regression tested whether the red box layout design did better at reducing the number of unsigned ballots.

Counties were the unit of analysis for the design tests since the envelope designs were by county. This used the total count of unsigned ballots or mismatched signatures per county as the dependent variable. This allows standard regression analysis instead of probit or logit. This is also in line with what election administrators need to know since it answers whether the ballot design will reduce the number of errors their office sees. If it can reduce the number of overall ballot errors, then it is more likely to convince an election official to adopt a change rather than focusing on decreases in the individual probability of someone having an error.

The initial results were not promising. On their own, none of the designs had any significant effect. The red box design in Table 6 came close to being significant but did not reach the p-level of 0.05 or less for 95% confidence. The front arrows and the power of attorney message fared the worst at a p-score of .184.

Table 4 Regression Analysis of Location Arrows

OLS Regression *unsigned ballots*

	Coefficient	Robust St. Err.	p
arrow Front	-369.0078	274.2193	0.184
arrow Back	-385.8464	224.4636	0.091
arrow Both	270.0914	155.8373	0.088
Language	253.2237	220.1549	0.255
VBM Count	0.0048094	.0021877	0.032**
constant	103.8038	221.6801	
N	64		
R-squared	0.4529		

**** 99% CI; ** 95% CI; * 90% CI; Non-standardized coefficients*

Table 5 Regression Analysis of Power of Attorney Key Words

OLS Regression *signature mismatches*

	Coefficient	Robust St. Err.	p
Power of Attorney	74.00251	55.07925	0.184
Language	40.79607	75.67432	0.255
VBM Count	0.0015506	.0006615	0.032**
constant	-50.12271	100.3604	
N	64		
R-squared	0.1981		

**** 99% CI; ** 95% CI; * 90% CI; Non-standardized coefficients*

Table 6 Regression Analysis of Red Box Layout

OLS Regression *unsigned ballots*

	Coefficient	Robust St. Err.	p
Red Box	-369.0078	274.2193	0.051
Language	88.64682	220.1549	0.623
VBM Count	0.0056862	.0021877	0.026**
constant	-305.495	221.6801	
N	64		
R-squared	0.4582		

**** 99% CI; ** 95% CI; * 90% CI; Non-standardized coefficients*

Vote by Mail Count

Figure 20 shows the distribution of mail ballots by county. The distribution is skewed with a right-side tail. The majority of counties have fewer than 50,000 mail ballots while the top fifth of the counties skews the results with volumes up to 500,000. Because there was a large variance in county size and correspondingly VBM counts I scaled the VBM count into near quintiles. The top quintile contains the counties with 125,000 up to 500,000+ ballots that skewed the VBM count overall. The remaining quintiles highlight just how small the remaining counties are. The bottom one-fifth of the counties have less than 3,000 mail ballots and thus see few errors overall. As with economies of scale, the scale of incoming mail ballots a county processes affects the budget, tools, and processes the county has available, so it makes economic sense to scale the VBM count so that it represents the county's size, budget, and process. The scaled approach makes the results more meaningful to election administrators as they can see

where their county fits into the scale more easily.

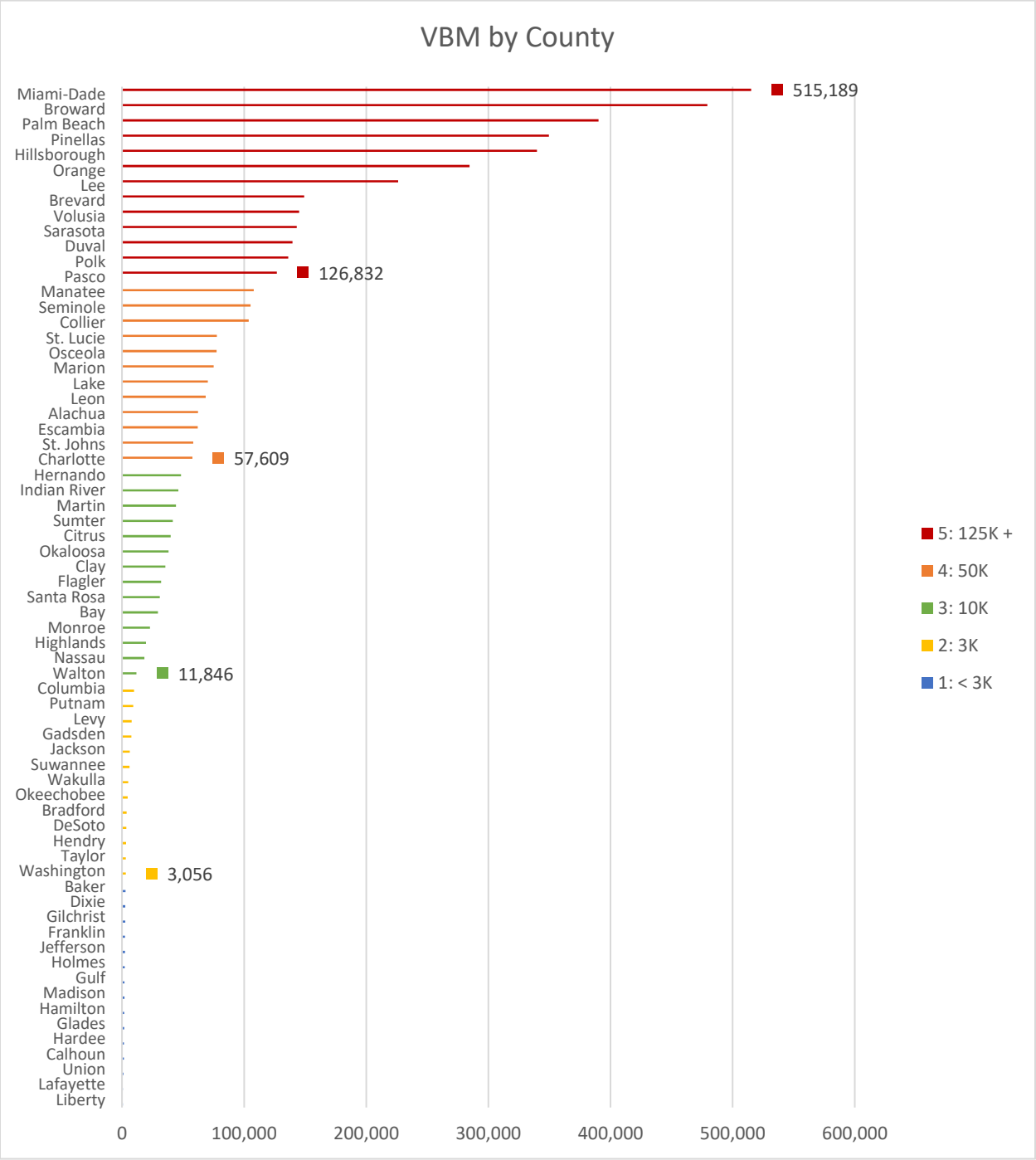


Figure 20 VBM Counts by County and Scaled VBM Category

The side effect is that the scaled VBM values often lost their significance whereas the original VBM count was always strongly significant. Overall, the number of ballot errors increases as the number of mail ballots increases as expected. By scaling the value, the coefficients, representing the number of expected errors per scale of ballots, continue to increase as the VBM scale increases.

In Table 8 the scaled model shows how much unsigned ballots increase at each level of the VBM scale. The significance, or p-values, drop out of significance, however. This was expected for the smaller-scaled values but the large end of the VBM scale also fell out of significance. This may indicate that counties that operate on the same scale in terms of the number of ballots still have differences in procedures that cause some to have higher or lower rates of ballot errors than other counties within the same scale. By scaling the VBM count then, the model gives a more detailed picture of what is happening within each scale rather than just the overall effect between the largest and smallest VBM count. Using the VBM count directly gives a better adjusted R-squared of .52 which shows the number of mail ballots coming in accounts for a large portion of the model. But to get a more detailed picture of what happens in each county based on size, the scaled VBM is more meaningful.

Table 7 Regression Analysis of Envelope Designs using VBM Count

OLS Regression *unsigned ballots*

	Coefficient	Robust St. Err.	p	per 1 SD
arrow Front	-414.3970	250.8690	0.104	-.3090
arrow Back	-377.4878	194.1613	0.057	-.3010
arrow Both	319.5918	139.7395	0.026**	.5784
Power of Attorney	-124.4834	117.8879	0.296	-.0977
Red Box	602.2397	257.9025	0.023**	.2580
Language	121.0475	205.8597	0.559	.0523
VBM Count	0.004777	.0020100	0.021**	.5038
constant	283.2146	255.154		
N	64			
R-squared	0.5253			

**** 99% CI; ** 95% CI; * 90% CI;*

Table 8 Regression Analysis of Envelope Designs using Scaled VBM

OLS Regression *unsigned ballots*

	Coefficient	Robust St. Err.	p	per 1 SD
arrow Front	-686.1213	409.3851	0.100	-.3090
arrow Back	-646.3173	336.8909	0.060	-.3010
arrow Both	437.2684	215.1103	0.047**	.5784
Power of Attorney	-73.73985	113.2866	0.518	-.0977
Red Box	703.2979	326.4668	0.036**	.2580
Language	437.683	504.6753	0.390	.0523
Scaled VBM				
3K	-294.9177	365.5183	0.423	-.1050
10K	25.5322	339.1168	0.940	.0093
50K	70.22285	454.4214	0.878	.0250
125K	687.7257	406.9636	0.097	.2525
constant	343.7432	432.5715		
N	64			
R-squared	0.4554			

**** 99% CI; ** 95% CI; * 90% CI;*

For the models in Table 7 and Table 8, I combined the location, keyword, and layout designs into a single regression to test the overall effects of each design. Since all designs appear on the ballot envelope, they can be considered to be working together rather than individually. When combined, the red box layout and having arrows on both sides became significant across all methods. This indicates that additions to the ballot design can work together for a greater effect. The red box layout and arrows, however, had the reverse effect on unsigned ballots. Counties using the red box design increased the number of unsigned ballots rather than decreasing them. This is the opposite of what I expected. I expected that the more distinctive red box layout would attract the voter's attention to the signature area. The same happened with the arrows. Only the combined effect of front and back arrows is significant, and it goes in the opposite direction of the arrows themselves. Since both the front and back arrows have to be present for the *arrowBoth* coefficient to be part of the regression equation, it only acts to negate the presence of the arrows. This means the presence of arrows has little to no effect.

Overall, the results are consistent suggesting the simpler designs are better. On their own, each feature of the design does not make a significant change, but in combination, they can. However, the more attention-getting red box design and arrows had the reverse effect suggesting simple designs are more effective. The more complex designs did not significantly change voter behavior nor reduce the number of unsigned ballots. The more complicated designs may be causing too much clutter or distractions. For the proposal of adding the voter's name under the signature line, the implication here is that the simpler design from the Center for Civic Design (2017) in Figure 8 would work best.

The other problem here is that the regression analysis may be attempting to measure too many changes at the same time. A more robust approach would be to use the proposed design in one county and do a difference-in-differences analysis of before and after results. This would remove errors due to the myriad of differences in each county's ballot. VBM counts alone are not enough of a control variable to account for all the variation in envelope designs. It also aligns with the current process of adopting envelope design changes where one county election official tries it in an off-year and reports the results to other counties.

It can be argued that the power of attorney test is most similar to adding the voter's name on the envelope. This would suggest that adding the voter's name would have no effect since the power of attorney results were ineffective in all models. However, power of attorney is not common whereas everyone has a name. People will skip past information that does not relate to them while homing in on items that do. Especially a person's name. Including the voter's name in a simple layout as in the Center for Civic Design layout (Figure 8) should be effective.

CONCLUSION

The anecdotal comments about household members signing the wrong ballot were empirically validated There is a significant household size effect on signature mismatches confirming hypothesis 1. Household members are signing each other's ballots. While the probability of a signature mismatch is extremely low to begin with, at only 0.009%, it does steadily increase as household size increases. The increase is also extremely low, increasing to only 0.018% at 10 people in the household. This may not present much of a problem for election administrators until they start processing a hundred thousand ballots or more, but it confirms another problem that they will run into. Another important aspect of this finding is that election administrators can attribute more of the signature mismatches to human error rather than bias by election officials. With conspiracy theories spreading about election procedures and machinery throwing out ballots (or not throwing out enough), this finding puts the blame back on the voter rather than bias in the signature matching devices or election officials. It is an error that election administrators can try to avoid by adding the voter's name.

Accounting for household size had no effect on signature mismatches attributed to race. Even though the data confirmed white households have smaller households overall, the larger household size for blacks and Hispanics did not decrease the number of signature mismatches previously attributed to race. Blacks and Hispanics had the same results with or without adjusting for household size. I did not further investigate why blacks or Hispanics had an increased number of signature mismatches. I can only confirm that it was not related to household size, therefore hypothesis 2 is rejected. I would also note here that while the results in Table 3 show that blacks and Hispanics were significant in this research, my research counted all

signature mismatches that occurred whereas most prior research only counted the ones that were not cured at some point during the process. Therefore, the results may not be comparable.

Ballot designs indicate that simpler is better. All of the hypothesis 4 predictions are rejected because they either produced no significant results or the results went in the opposite direction. Since the more attention getting designs returned results indicating they work in the opposite direction, the lesson is that the simpler designs work better. It would be more practical to have one election office test the design so that there is only one design change being tested at a time. This would limit interference from other effects and would provide a set of before and after results to empirically compare. The problem is still in convincing election administrators to make a change. While this research has confirmed that there is a problem with household members signing the wrong ballot, changing the envelope design to correct it may present more difficulties in printing and scanning than the effort is worth. Therefore, the simpler design from the Center for Civic Design (Figure 8) is recommended over my original design (Figure 7) which attempts to move the signature area to match where the voter name is already printed in the mailing window. The latter design is vastly more complicated and is likely to cause as many printing and scanning issues as it tries to solve.

Any design changes may at best only reduce the number of errors by fractions of a percent. Still, there are 15 million voters in Florida with 4.9 million mail ballots processed in 2020. Florida is known for close races and recounts. In 2018, three top-ticket races, the US Senate race, gubernatorial race, and a state cabinet race were all close enough to trigger mandatory recounts. In 2020, the Florida State Senate seat for District 37 in Miami was decided

by only 32 votes, triggering a manual recount and investigations into election fraud (Gross, 2020). This gives evidence that close races are to be expected.

Florida is infamous, however, for the hanging chad debacle of the Bush/Gore race in 2000. The incident shows how minor flaws in ballot design can lead to processing errors and ambiguity in voters' intent. Because of this, punch-card ballots were banned by the Help America Vote Act in 2002 (ES&S, n.d.). More recently, by placing the voting instructions in the first column along with the first race for US Senate, the 2018 ballot for Broward County, Florida, caused voters to skip over the US Senate race (Ross, 2020). The Florida Legislature responded by requiring the voting instructions to be at the top of the ballot, separated from the races. In both cases, design changes were made to prevent the problem in the future, but were election officials aware of the potential problems beforehand? By empirically validating that household members are signing the wrong ballot, it informs election administrators that there is an existing problem. Ideally, the design solution of placing the voter's name under the signature line can be implemented to prevent the problem before it becomes a state-wide or national media fiasco.

Finally, it's also a way for election officials to reduce costs. Every rejected ballot that comes in requires more election officials to review it along with efforts to contact the voter by phone, email, and regular mail. To make a small design change to the envelope that will prevent errors later is worth the cost.

Future Research

I plan to continue working with election administrators and the Center for Civic Design to see if there is a more feasible design that could be tested. More importantly though, while my research did not find the household size to affect racial results it is still worth investigating the racial results further. The prior research that led to this study often found and reported racial effects but too often we do not know the real cause. Having information on the voter's race allows us to see racial outcomes, but it does not give a contextual picture that identifies where the discrepancies are coming from. By looking at household members signing the wrong ballot, I was able to pinpoint a specific cause that may be having a racial effect. While it didn't have a noticeable effect, the goal of trying to identify potential causes of racial differences is still there.

APPENDIX A: DUPLICATES

Voters registered by the book closing date can request a mail ballot up to ten days before the election. Therefore, the mail ballot status will have more mail addresses than the voter file as voters request a mail ballot after the voter registration files have closed. Voters that have moved can also update their addresses after book closing. This is seen in the mail ballot status with a voter ID appearing in two or more counties. This causes duplicate entries in the data.

The matching to select which record is the duplicate is:

1) If the status is V for voted, E=Error, or N=Not Signed, then that record is kept as the original
2) If the status is U for Undeliverable, R=Requested, or S=Standing (Not Sent or Not Delivered), then the other record is kept as the original
3) If the return date is not null, the record is kept as the original. The status can be C=Cancelled and have a return date, indicating that the voter only wanted a mail ballot for the current election.
4) If the status is P for Provided, then that record is kept as the original. It is assumed that the voter is correctly registered in the county but did not return the ballot.
5) If the sent date is not null, then that record is kept as the original
6) Otherwise, the first entry in the pair is chosen.

APPENDIX B: COPYRIGHT PERMISSIONS

I received permission from the Civic Center for Design to use images from their published field guide. A pdf copy of the original can be provided upon request.

9/29/2021

From: Craig Wilding

775 Oakland Hills Cir. # 103
Lake Mary, Fl 32746
407-335-9190
Craig.Wilding@Knights.ucf.edu

RE: Copyright Permission

Center for Civic Design

Dear Pari Sabety:

I am requesting permission to reprint images from the following work:

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- Return Envelope Front, page 6
- Return Envelope Back with Overprinting, page 7
- Back of Return Envelope, page 13,
- Form with voter information printed, page 15

Permission is given, providing you use the updated images with the purple sidebar included in https://civicdesign.org/wp-content/uploads/2020/04/6x9VBM-Return-Envelope-TEMPLATE-20200406Folder.pdf

This request is for permission to include the above content in my masters' thesis paper: "*Mail Ballot Signature Rejections: Household Members Signing Each Other's Ballots*". The paper looks at the number of mismatched signatures due to household members signing the wrong ballot. It proposes changing the ballot envelope design to include the voter's name near the signature area in order to reduce the chances of this error occurring. Your guide was the only source I could find that also placed the voter's name by the signature line. I wish to include the images as an example of current recommendations.

My thesis paper will be published in the University of Central Florida thesis archive and may be republished in full or in part in other academic publications.

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If you agree with the terms as described above, please sign the letter where indicated below and return one copy to the address above.

Sincerely,

Craig Wilding
MA Graduate Student
Political Science
University of Central Florida

Permission is hereby granted:

Signature: Whitney Quesenbery Date: Sept 30, 2021
Name & Title: _Whitney Quesenbery, Executive Director
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